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3 STEADY GEOMAGNETIC MICROPULSATIONS AND SOLAR CORPUSCULAR STREAMS 5 pg 1

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STEADY GEOMAGNETIC MICROPULSATIONS AND SOLAR CORPUSCULAR STREAMS*

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SUMMARY

A specific type of geomagnetic pulsation is juxtaposed with every type of solar corpuscular stream originating from the unperturbed regions of the Sun, from the active regions and from chromospheric flares.

On the basis of the study of morphological properties of these types of pulsations conclusions are derived about the different geometry of the streams inducing these pulsations and the variation of the radiation intensity level of these various types of streams in the solar activity cycle.

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As is well known, there exist several levels of solar corpuscular radiation [1], to each of which corresponds an entirely specific magnetic activity that finds its reflection in the quantity K_p. Thus, as a rule, the zero level of magnetic activity (K_p = 0 to 1) corresponds to a continuous flow of gases from the unperturbed regions of the Sun — the solar wind. The quasistationary streams from the active region of the Sun induce recurrent magnetic disturbances (K_p = = 3 to 5), and the nonstationary streams from chromospheric flares induce sporadic storms and the highest magnetic activity ($K_p > 5$).

On the other hand, there exists between the period Pc and the geomagnetic activity a specific dependence, where to each K_p interval corresponds a specific type of pulsation with period decrease as the level of activity rises [2]. Thus, for example, mainly steady pulsations are observed in the interval K_p = 0 to 1, with a period T = 50 to 100 sec. (Pc4). At K_p = 2 to 5, we observed in most cases regimes of steady pulsations with periods from 10 to 40 sec. (Pc2).

The inverse dependence of T_{Pc} on K_p is plotted in Fig.1, from which a correspondance may be seen between every type of Pc and a specific range of values of K_p. The question naturally arises of the possibility to characterize each level of solar corpuscular radiation from the standpoint of the properties

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*5USTOYCHIVYYE GEOMAGNITNYYE MIKROPUL'SATSII I SOLNECHNYYE KORPUSKULYARNYYE POTOKI6

of the corresponding groups of geomagnetic pulsations and of variation of these properties in the solar activity cycle.

Let us consider the properties of this group of pulsations. As is well known, the variations of the geomagnetic field and, in particular, the steady oscillations of the Pc type, have a daily, seasonal and annual course, which is conditioned by the mutual position of the point of observation on the ground surface and of the Sun. The variations are subject to change with the phase of the solar activity cycle. These regularities of the steady geomagnetic pulsations will be utilized as the characteristics of the properties of the different levels of solar corpuscular radiation. The processing of data was conducted according to the readings of variations of the Z- and H-components of the geomagnetic field at the stations Borok and Petropavlovsk-Kamchatskiy for the period 1957-1964. Basically the daily course of the frequency of Pc appearance for various and the seasonal variations and the course of various types of Pc in the solar activity cycle served as material for the analysis (Pc of median amplitudes).

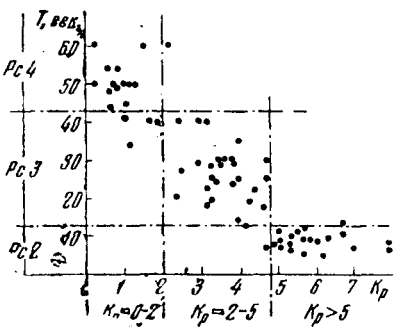

Fig.1

The different position of the maxima of the daily course of various groups' Pc and the nonidentical shift of this maximum in the solar activity cycle may apparently be explained by the deviation of the direction of the solar corpuscular stream inducing the Pc of the given type from the line Earth-Sun and the different variation of this deviation as a function of the phase of the solar activity cycle. We shall consider the regularities of the excitation of steady oscillations separately for each group.

Pc4 Pulsations. This type of pulsation corresponds to the quiet radiation of the Sun — the solar wind. The daily courses of the frequency of Pc of the given type appearance are plotted in Fig.2. The number of cases of the given type-Pc for the period 1957-1964 is plotted in the ordinates, the interrupted line being drawn through the local noontime. As may be seen, the Pc4 maximum corresponds to 11 - 12 hours local time. Pc4 arise almost at the moment of time when the point of observation emerges on the illuminated side of the Earth; they attain the maximum approximately during the local noontime and vanish during the passage to the dark side. The maximum frequency of Pc4 appearance coincides in time with the position of solar wind zero velocity point, which is not on the axis Sun-Earth, but somewhat shifted westward relative to the Sun as a result of solar wind interaction with the magnetosphere surface [5].

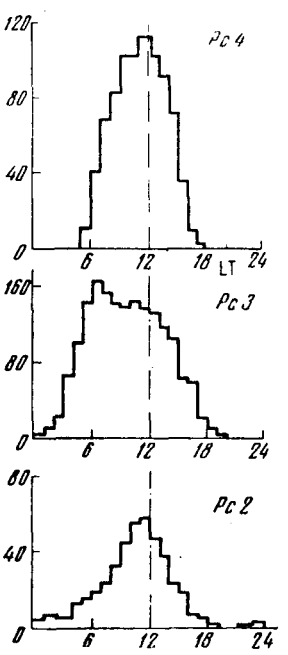

Fig.2

The median amplitude of Pc3 also undergoes variation with the phase of solar activity, decreasing from the epoch maximum to minimum by a factor of 2 (Fig.4). Thus, one may assume that contrary to the constancy of solar radiation from the unperturbed regions the level of radiation from active regions varies about twice as much with the phase of solar activity, as may be seen from the data on short-period oscillations.

Pulsations Pc3. This type of pulsation attends mainly sporadic perturbations. The maximum of Pc2 appearance corresponds to 11 - 12 hours L.T. (Fig.2). Just as is the case for Pc4, the distribution of Pc2 in the course of a day in the solar activity cycle, undergoes no variations of any kind (Fig.3), while the median amplitude of Pc2 somewhat decreases. Apparently the maintenance of the position of the quantitative Pc2 distribution maximum in the course of a day in the solar activity cycle may constitute evidence of invariable direction of nonstationary streams from chromospheric flares.

Discussion of the Results. Comparing the distribution of the various types of pulsations in the course of a day, we detect a difference in the character of the quantitative distribution of these oscillations relative to local noon (Fig.2). This difference is manifest in that the frequency maximum of appearance of type-Pc4 and Pc2 pulsations in the course of a day has a shift toward the forenoon side by about 1 hour, whereas Pc3 shows a shift by 2 to 2.5 hours. This shift is apparently due to the difference in the direction of corpuscular streams inducing these pulsations. The practical coincidence of the maximum of Pc4 and Pc2 distribution with the direction Sun-Earth corroborates the assumption of quasiradial propagation of solar wind and of streams from chromospheric flares. The small deflection of the daily course of the frequency of Pc4 appearance from the local noon, may apparently be juxtaposed with the revealed deviation to the East of the solar wind [7]. This effect is induced by interaction between the interplanetary magnetic wind and the solar wind, of which the result is analogous to solar wind arrival from a source situated by 10 to 25° to the West of the Sun. As an average, this angle corresponds to the displacement of the maximum frequency of Pc4 appearance to about 1 hour earlier than the local noontime.

The sharply expressed spiral structure may be expected only in quasistationary streams from active regions [1]. On the other hand, a notable shift of the frequency maximum of excited Pc toward the forenoon side of the line Earth-Sun can be observed only in the presence of spiral character of the corpuscular outflow. Such a shift is observed in the type-Pc3 pulsations about 2 to 2.5 hours prior to local noontime.

Conclusions. To each intensity level of solar corpuscular radiation corresponds a specific group of type-Pc geomagnetic pulsations:

1) Pc4 (50 to 100 sec.) correspond to continuous outflow of solar gases from the unperturbed regions;
2) Pc3 (10 to 40 sec.) correspond to quasistationary radiation from the active regions of the Sun;
3) Pc2 (5 to 10 sec.) correspond to nonstationary radiation from chromospheric flares.

It should be noted that although solar wind is emitted by the Sun continually in all directions, comparatively nondense condensations of solar wind originating from unperturbed regions do not penetrate into the dense gas flows from the flares and active regions; because of that every type of corpuscular radiation will react independently. The random appearance of regular Pc4 in the course of sporadic or recurrent perturbations may apparently be explained by very great inhomogeneity of corpuscular streams, as a result of which the Earth will be subject at certain moments of time to action from the side of the more rarefied volumes of the stream, capable of exciting type-Pc4 pulsations.

Comparison of morphological singularities of steady pulsations of various groups with specific levels of solar corpuscular radiation intensity may provide new information on the character and properties of this radiation:

a) on the constancy of direction and intensity level of solar wind in the solar activity cycle on the basis of the maintenance of the position of the maximum daily course of frequency appearance and of the value of median amplitude of Pc4 in the solar activity cycle;

b) on the spiral structure of quasistationary streams from active regions of the Sun and on the variation of this radiation's intensity in the cycle of solar activity on the basis of the shift of the daily course maximum of the frequency of Pc3 appearance and of the lowering of median Pc3 amplitude level the solar activity cycle.

c) on the maintenance of the quasiradial propagation direction of solar corpuscular streams from chromospheric flares in the solar activity cycle on the basis of invariable position of the daily course maximum of Pc2.

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REFERENCES

1. E. R. MUSTEL'. Astron. zh., 41, No. 5, 1964.

2. O. V. BOL'SHAKOVA. Geomagn. i aeronomiya, 5, No. 4, 775, 1965.

3. M. V. OKHATSIMSKAYA, YU. B. RASTRUSIN, I. I. ROKITYANSKIY, R. V. SHCHEPETNOV. Sb. "Korotkoperiodichesiye kolebaniya elektromagnitnogo polya Zemli," No. 3, Izd-vo A. N. SSSR, 17, 1961.

4. P. A. VINOGRADOV. Sb. "Korotkoperiodicheskiye kolebaniya elektromagnitnogo polya Zemli," No. 3, Izd-vo, A. N. SSSR, 23, 1961.

5. W. J. AXFORD. J. Geophys. Res., 68, 5883, 1963.

6. O. V. BOL'SHAKOVA. Astron. zh., 42, No. 4, 859, 1965.

7. G. K. WALTERS. J. Geophys. Res., 69, 1769, 1964.